Space Weather Technical Forecast

Issued on Thursday, 21 April 2022 at 01:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance X-flares (R3 Radio Blackouts), with further M-class flares (R1/R2 Radio Blackouts) likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity has been High with peak flare X2.2 observed at 20/0357 UTC from AR2992 which had rotated over the SW limb, and was perhaps partially occluded. This was also the source of a number of M-flares, include an M7 flare around 20/0134 UTC although this did occur alongside some brightening of AR2994 that was visible in SDO aia-94. A large complex region of sunspots is situated in the northeast disc, primarily comprising AR2993 Eki/ beta-gamma and AR2994 Eko/beta-gamma but also have a couple of smaller and simpler regions following, including AR2995 Hhx/alpha and two unnumbered regions. Elsewhere on the disc, there is one small sunspot AR2991 Axx/alpha on the central southern disc. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind speed has declined from around 450 km/s to just below 400 km/s. The density was average or below average before increasing above average ending the period around 15 ppcc. The magnitude of the Interplanetary Magnetic Field, Bt, was weak throughout, below 8 nT, with its north-south component, Bz, varying between +7/-5 nT. The phi angle was largely positive (away from the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at Background levels throughout. The high energy electron flux (greater than 2MeV) reached High levels at the diurnal maximum, with 2030 pfu recorded at 20/1755 UTC. The corresponding 24-hour integrated electron fluence was on a steady trend, close to the Active threshold but has recently eased to just below. This reached a value of 7.46e7 integrated pfu at 20/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate over the next four days, with a chance of X-class flares (R3 Radio Blackouts), mainly from the large and fairly complex regions currently in the northeast quadrant. There is on ongoing likelihood of M-flares (R1/R2 Radio Blackouts)

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds at earth are expected to be mostly Background to slightly elevated. There is a slight chance of a weak enhancement during day 1 (21st) from the arrival of the fast wind of CH76. This feature is no longer visible, but was evident when in the Earth-facing central disc, and also potentially the source of a weak enhancement at STEREO A late on the 18th, observing conditions around 2.5 days before Earth. Geomagnetic activity is forecast to be mostly Quiet to Unsettled with a slight chance of Active should any weak coronal hole features impact Earth, or perhaps an unexpected transient.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the most complex regions rotate westward. The high energy electron flux has been generally Moderate, with High levels reached during the diurnal maximum, this is likely to continue. The associated fluence is near the Active (1e8 integrated pfu) threshold, but is likely to stay just below this level, with a chance of rising above.

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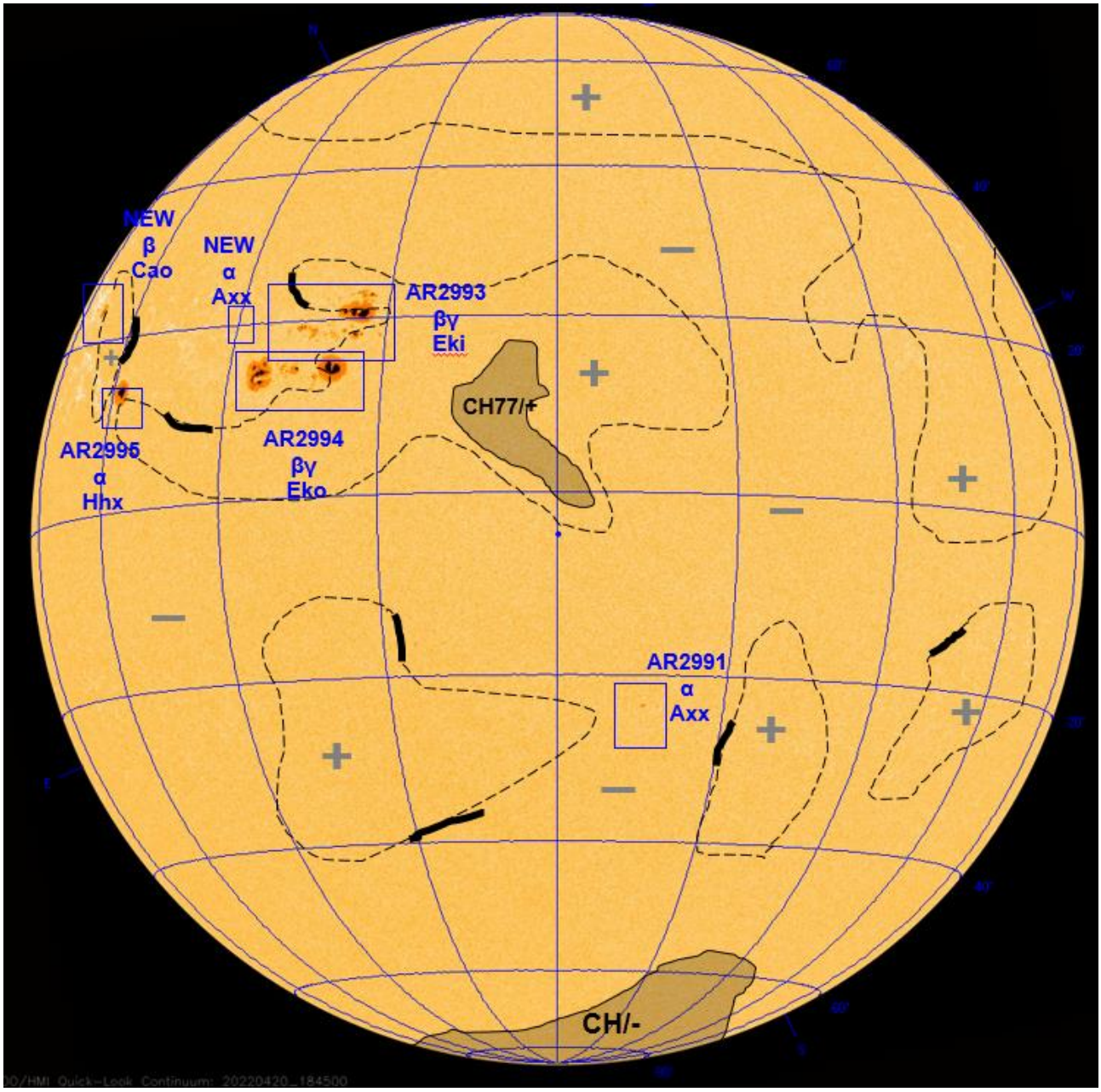
Figure 1. Solar Analysis Valid 20/1900UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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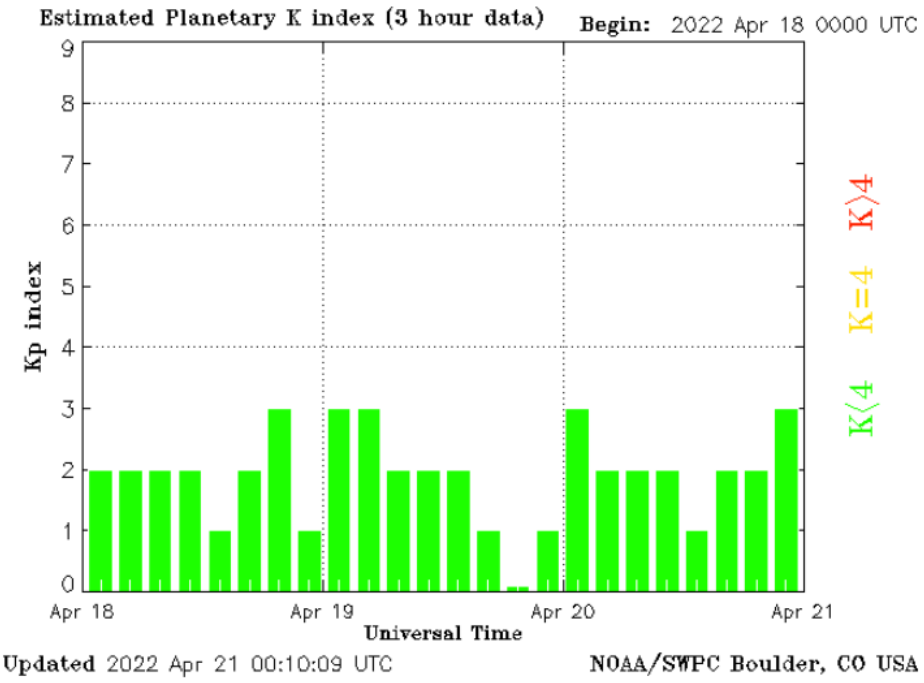
Geomagnetic Storms:

There are no Earth-directed CMEs.
Earth has seen recent fast wind enhancement from CH75 subside, with solar winds easing to be slightly elevated to background. There is a slight chance of a weak enhancement during day 1 (21st) from the arrival of the fast wind of CH76. This feature is no longer visible, but was evident when in the Earth-facing central disc, and also potentially the source of a weak enhancement at STEREO A late on the 18th, observing conditions around 2.5 days before Earth.
Geomagnetic activity is forecast to be mostly Quiet to Unsettled with a slight chance of Active should any weak coronal hole features impact Earth, or perhaps an unexpected transient.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2: Planetary K index (Kp) as measured by NOAA SWPC



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Radio Blackouts - X-Ray Flares:

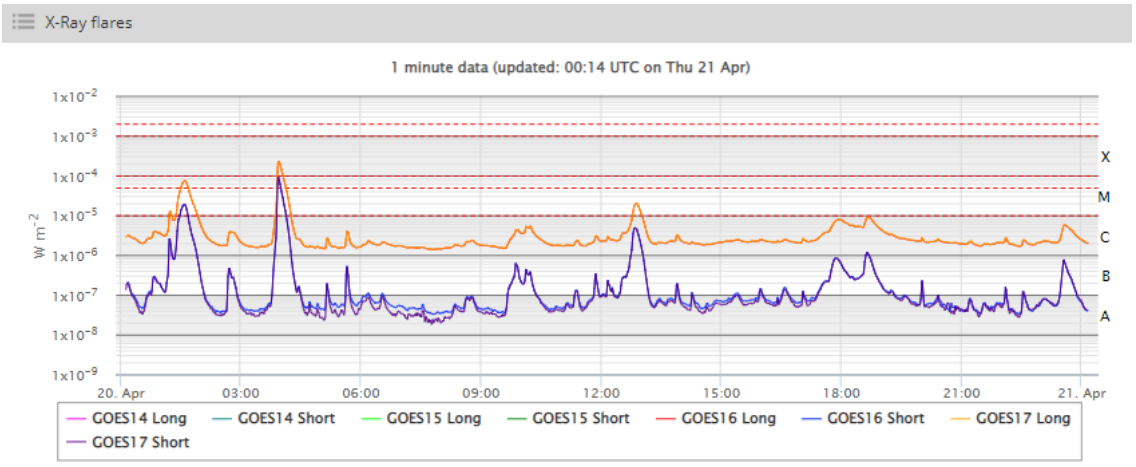
Solar activity is currently High due to occurrence of a strong X2.2 flare from AR2992 from over the southwest limb. Activity through the day from this region is much reduced as it continues to rotate away from an observable location. Consequently any further significant flaring from this region is considered unlikely.

AR2993 Eki/Beta-gamma and AR2994 Eko/Beta-gamma remain large and relatively complex regions in the northeast disc with a significant associated magnetic flux in their surrounding area. The latter of these regions was the source of a strong X1.1 flare on the 17th, although both of these regions have subsequently seen activity reduce to mostly C-flares. An M7 flare was observed at 20/0134UTC, and whilst likely to be primarily from AR2992 over the limb, some brightening was also observed in AR2994 in SDO aia-949 at the same time. Alongside this apparent reduction in activity, some of decay are evident in AR2994, with its intermediate spots fading. However some brightening and consolidation of visible looping in SDO aia-171 and aia-94 suggests there is still a potential for notable flaring. Further M-flares are likely from these spots, with a chance of X-flares.

There are four other regions on the Earth-facing disc, including three closer to the northeast limb. These are AR2995 Hhx/alpha, which is currently a simple unipolar region, and a new Cao/beta region that has rotated on but is yet to be numbered. A newly developed Axx/Alpha has also emerged to the east of AR2993, which could be part of the same complex. A further small region AR2991 is situated in the southern central disc. These regions are notably smaller, and less likely to give significant flares at this stage.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	Yes	20	20	20	20

Figure 3: GOES16 X-Ray flares shows the early X2.2 flare which is the largest flare so far of Solar Cycle 25. Subsequent flare activity unremarkable.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days. An X2.2 flare was observed from AR2992 just over the southwest limb, however proton flux remained at background. Observable flares from this region are becoming less likely.
Otherwise AR2993 and AR2994 form a complex of sunspots across the northeast disc that is gradually rotating into a more geoeffective position for proton enhancement. Any notable flares from these regions have a slight, but increasing potential for proton storms to occur at Earth through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	7	10	12
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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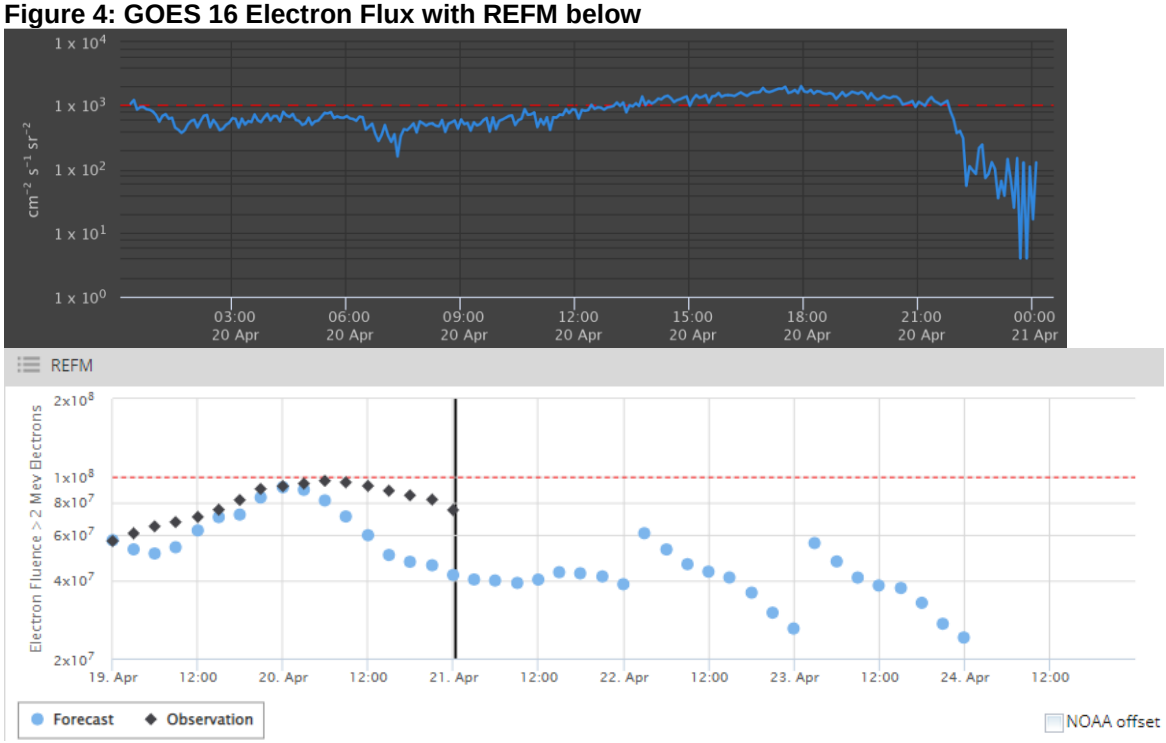
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO has been varying between background and peak High levels. Any potential arrival of a further fast wind on day 1 could bring a drop out of flux returning to mainly background to Moderate levels. This arrival is low confidence however, with the potential for background to high levels to continue through the period, should this not materialise.
The associated Electron fluence peaked at just below the Active threshold on the 20th, with a greater chance of rising just above on day 1 (21st), before the influence of any fast wind arrival then occurs. If any drop out in flux is observed, then the chance of Active fluence throughout the rest of the period will decline. However, this arrival and potential dropout is low confidence, with REFM showing the potential for an increasing trend, should this not occur. Consequently a 30% chance of Active fluence is maintained.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	30	30	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: GOES 16 Electron Flux with REFM below



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